Motivation and mortality in older women with early stage breast cancer: A longitudinal study with ten years of follow-up

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Abstract

Objectives: The Getting Out of Bed Scale (GOB) was validated as a health-related quality of life (HRQoL) variable in older women with early stage breast cancer, suggesting its potential as a concise yet powerful measure of motivation. The aim of our project was to assess the association between GOB and mortality over 10 years of follow-up.

Materials and Methods: We studied 660 women ≥ 65-years old diagnosed with stage I-IIIA primary breast cancer. Data were collected over 10 years of follow-up from interviews, medical records, and death indexes.

Results: Compared to women with lower GOB scores, women with higher GOB had an unadjusted hazard ratio (HR) of all-cause mortality of 0.78 at 5 years, 95% confidence interval (CI) (0.52, 1.19) and 0.77 at 10 years, 95%CI (0.59, 1.00). These associations diminished after adjusting for age and stage of breast cancer, and further after adjusting for other HRQoL variables including physical function, mental health, emotional health, psychosocial function, and social support. Unadjusted HRs of breast cancer-specific mortality were 0.92, 95%CI (0.49, 1.74), at 5 years, and 0.82, 95%CI (0.52, 1.32), at 10 years. These associations also decreased in adjusted models.

Conclusion: Women with higher GOB scores had a lower hazard of all-cause mortality in unadjusted analysis. This effect diminished after adjusting for confounding clinical and HRQoL variables. GOB is a measure of motivation that may not be independently associated with cancer mortality, but reflects other HRQoL variables making it a potential outcome to monitor in older cancer patients.

Introduction

The number of cancer survivors is expected to grow to 19 million by January 2024, contributed by advances in detection and treatment as well as an aging population (1). About 40% of new breast cancer diagnoses occur in those ≥65 years old, and these patients comprise the majority of breast cancer deaths and current breast cancer survivors (2). Among the challenges of caring for older patients with cancer is appropriately balancing treatment outcomes, such as survival, with health-related quality of life (HRQoL) (3). There is growing evidence that HRQoL in cancer patients of all ages is not only an important outcome in itself but also a predictor of mortality (4-7).

Motivation plays an important role in an older patient's ability to overcome illness and stay engaged with healthy behaviors. Clough-Gorr et al. developed and validated a measure of motivation called the "Getting-Out-of-Bed (GOB) Scale" in a large cohort of older patients with early stage breast cancer (8). GOB was shown to correlate with several other HRQoL measures such as mental health and physical functioning, however GOB predicted certain outcomes and behaviors, such as participating in regular exercise, that were not predicted by HRQoL. Their results suggested that GOB reflects aspects of motivation potentially relevant to health behaviors and outcomes that overlap conceptually with, but are not entirely captured by, HRQoL. Measures similar to motivation, such as optimism and hope, have been linked to both disease-specific and all-cause mortality (9-11). However, GOB's ability to predict mortality, either independently or in association with HRQoL, has yet to be studied.

In this secondary analysis of the same cohort of older women with early stage breast cancer studied by Clough-Gorr et al., we assessed the association between GOB and 5- and 10-year mortality, both all-cause and breast cancer-specific (BC-specific). We hypothesized that higher GOB scores would be associated with lower all-cause and BC-specific mortality. Moreover, we hypothesized that GOB would independently predict mortality, and included potential confounding clinical and HRQoL variables in our analysis to test this hypothesis. **Figure 1** summarizes these hypothesized relationships: HRQoL measures have a direct effect on mortality and are associated with GOB. Knowledge of HRQoL will therefore allow an investigation into whether GOB has an independent effect on mortality (12).

Materials and Methods

Study Population

The longitudinal study design and subject recruitment procedures have been reported previously (13). In brief, 660 women ≥65-years old with stage I tumor diameter ≥1cm or stage II-IIIA disease and permission from attending physicians to be contacted in four geographic regions (Los Angeles, California; Minnesota; North Carolina; Rhode Island) were identified through regular pathology report review at hospitals or collaborating tumor registries. Women could not have a prior primary breast cancer or simultaneously diagnosed or treated second primary tumor. Data were collected by medical record review (definitive surgery date, surgery type, tumor characteristics) and telephone interviews (socio-demographic, HRQoL variables, breast cancer therapy) beginning at least three-months after surgery and continuing annually for 10 years. Causes of death – characterized as breast cancer-specific, all-cause, all-cancer-related – were collected through 10 years of follow-up.

Mortality, all-cause and breast cancer-specific

Decedents were identified by first and last name, middle initial, Social Security number, date of birth

(DOB), sex, race, marital status, and state of residence matched against National Death Index (NDI) and Social Security Death Index (SSDI) records (14). Survival status at the end of 2007 was complete for all women.

Socio-demographic characteristics

We classified patient age as 65–69, 70–79, ≥80-years; race as white, other; education as <12-years, 12-years, >12-years; and marital status as married (yes/no).

Breast cancer characteristics

We categorized stage as I-III using the TNM classification (15). Definitive primary therapy was mastectomy plus axillary lymph node dissection (ALND) or breast-conserving surgery (BCS) plus ALND.

Getting out of Bed

GOB (**Table** 1) consists of four items scored on an ordinal scale of 1 to 5. The language used in these items was intended to be straightforward using concepts and terms universally understood at a layperson's level of understanding. GOB total score is calculated as an equally weighted sum of items (1=poor, 2=fair, 3=good, 4=very good, 5=excellent) giving a total score range from 4 to 20. The final score is transformed to 0-100, with a higher score indicating greater motivation (8).

Health-related quality of life characteristics

To further evaluate an independent association between GOB and mortality, we studied other HRQoL measures as potentially confounding variables in adjusted analyses, including physical function, general mental health, emotional health, psychosocial function, and social support. Physical function has been linked to mortality in older patients with cancer (7, 16). Moreover, physical function has been shown to be associated with other measures similar to motivation (8, 17-19). We calculated physical function using the 10-item Physical Function Index (PFI-10) from the Medical Outcomes Study Short Form-36 (MOS SF-36) (20). PFI-10 specifically has previously been linked to mortality in men and women (21, 22). Mental health has also been linked to survival in both older and younger cancer patients (23, 24). Furthermore, mental health has been shown to be associated with GOB and other measures similar to motivation (8, 25-27). General mental health was assessed by the Mental Health Index (MHI-5), a five-item measure of mental health from the MOS-SF-36 (20). MHI-5 specifically has been linked to mortality in cancer patients and in other populations (14, 28, 29).

Emotional health, psychosocial function, and social support have all been associated with measures similar to motivation (8, 30, 31). Breast cancer-specific emotional health (BCSEH) was assessed using a four-item measure reflecting how well the respondent was dealing with breast cancer-specific worries (32). We used the Psychosocial Summary Scale of the 17-item Cancer Rehabilitation Evaluation System-Short Form (CARES-SF) to capture cancer-specific psychosocial function (33). The CARES-SF item scores range from 1 to 4 (a higher score indicating more problems). Social support is related to survival in patients with breast and other cancers (34, 35). Social support was measured using a reduced set of eight items derived from the 19-item MOS Social Support Scale (mMOS-SS) (36).

All of the above HRQoL measures were transformed to a 0-100 score, with higher scores indicating better physical function, mental health, emotional health, social support, and psychosocial function, respectively.

Statistical methods

The study population was described by counts, percentage (%), mean, standard deviation (SD), median, and interquartile range (IQR). We used Spearman's rank correlation coefficient as an estimate of correlation. Mortality rates were calculated by the number of events divided by the total person-years under observation. We used Multiple Imputation (MI) to address missing baseline data, using a fully conditional specification approach (37). We assumed missing data to be missing at random (MAR) (38). In addition to variables used in the main analysis model, including GOB, age, stage of breast cancer, PFI-10, MHI-5, BCSEH, CARES-SF, and mMOS-SS, we used enrollment site, education, number of comorbidities, body mass index, type of therapy, tamoxifen prescribed, recurrence of breast cancer, and received chemotherapy in the imputation model to make the MAR assumption more plausible (39). Further, we included survival status and the Nelson-Aalen estimator in the imputation model to account for survival (38). We imputed continuous variables by predictive mean matching and categorical variables by polytomous logistic regression. We generated 25 multiple imputed datasets. All reported results are based on MI. As a sensitivity analysis we report complete case results. The associations between GOB and survival time were evaluated by modeling the hazard of dying using Cox regression models from all-cause mortality and BC-specific mortality. We did the same to assess the association between GOB and all-cancer mortality. We report hazard ratios (HR) as effect measures. Observation time began at the date of definitive surgery and ended on the date of death, 31 December 2002 (5-year survival) or 31 December 2007 (10-year survival), whichever came first. The proportional hazard assumption was tested by Schoenfeld's test (40). We present unadjusted models (i.e., Model 1: only GOB as predictor), and models adjusted for 1) age, stage of breast cancer (Model 2), and then additionally for 2) PFI-10, MHI-5, BCSEH, CARES-SF and mMOS-SS (Model 3). GOB and HRQoL measures were *a priori* dichotomized at a cutoff point of ≥ 80 versus < 80 (14, 41). A cutoff of 80 was chosen since it was similar to the other cutoffs used and nearly equally divided the population in half. To account for the possibility that GOB might be associated with mortality but with a different cutoff, we performed a sensitivity analysis using GOB and the HRQoL measures as continuous linear predictors, i.e. on their original 0-100 scale, in modeling.

Approval of the study was obtained from each institutional review board associated with the four geographic regions from which the study participants were identified and consented.

Results

Study population

Socio-demographic, breast cancer, and HRQoL characteristics of the baseline study population are shown in **Table 2**. The majority of women were ≥ 70 years (74.0%), white (93.9%), and had at least 12 years of education (82.4%). Approximately half had stage I disease and the majority (82%) received either a mastectomy, or BCS followed by radiation. Nearly half (47.7%) of the population had GOB ≥ 80, 64.8% had PFI-10 ≥ 80, and 68.9% had MHI-5 ≥ 80. 61.1% had BCSEH ≥ 80, 57.7% had CARES-SF ≥ 80, and 50.5% had mMOS-SS ≥ 80. The percentage of missing values of baseline characteristics ranged from 0.1% (missing BC stage) to 6.8% (missing BCSEH) with 3.6% of GOB baseline values missing.

GOB and mortality

Through 31 December 2002 (five years of follow-up), 99 (15.0%) women died, and of these, 39 (39.4%) were due to breast cancer, with 2712 persons-years of observation. The 5-year all-cause mortality rate was 3.6%, 95%CI (3.0% - 4.4%), and the 5-year BC-specific mortality rate was 1.4%,

95%CI (1.1% - 2.0%). Through 31 December 2007 (10 years of follow-up), 230 (34.8%) women died, and of these, 72 (31.3%) were due to breast cancer, with 5179 persons-years of observation. The 10-year all-cause mortality rate was 4.4%, 95%CI (3.9% - 5.1%), and the 10-year BC-specific mortality rate was 1.4% 95%CI (1.1% - 1.8%).

Table 3 displays the results of unadjusted (Model 1) and adjusted regression models (Model 2: adjusted for age and stage of BC, and Model 3: adjusted for age, stage of BC, and HRQoL measures) at both at 5- and 10-year time points. At 5 years, women with GOB $\geq$ 80 had an unadjusted HR of all-cause mortality of 0.78, 95%CI (0.52, 1.19), compared to women with GOB < 80. In adjusted models this hazard ratio increased to 0.87, 95%CI (0.57, 1.32), in Model 2, and to 1.04, 95%CI (0.65, 1.66), in Model 3. At 10 years, women with GOB $\geq$ 80 had an unadjusted HR of all-cause mortality of 0.77, 95%CI (0.59, 1.00), compared to women with GOB < 80. This HR increased from Model 2 [HR 0.84, 95%CI (0.64, 1.10)] to Model 3 [HR 1.08, 95%CI (0.80, 1.46)]. Unadjusted HRs of BC-specific mortality were 0.92, 95%CI (0.49, 1.74), at 5 years, and 0.82, 95%CI (0.52, 1.32), at 10 years. These HRs also increased in adjusted models. There was no evidence of violation of the proportional hazard assumption across all covariates. Kaplan-Meier survival curves from complete case results are shown in **Figure 2**, showing trends toward improved all-cause and breast cancer-specific survival in patients with GOB $\geq$ 80. **Table 4** shows the Spearman rank correlations among baseline HRQoL measures. Weak to moderate positive correlations were found between GOB and PFI-10, MHI-5, BCSEH, mMOS-SS, and CARES-SF.

Supplemental Table 1 summarizes sensitivity results from a complete case analysis. Estimates are comparable to estimates from **Table 3**. **Supplemental Table 2** reports MI Cox regression estimates using GOB and HRQoL measures as linear variables per one-unit standard deviation increase. The results are similar to results using dichotomized variables. **Supplemental Table 3** shows results from adjusted and unadjusted regression models testing the association between GOB and all-cancer mortality. At 5 years, women with GOB $\geq$ 80 had an unadjusted HR of all-cancer mortality of 0.86, 95%CI (0.50, 1.48) that increased towards 1 after adjusted analyses. Results were similar at 10 years.

Discussion

In a cohort of older women with early stage breast cancer we determined whether a measure of motivation, the 4-item GOB scale, was associated with mortality over 10 years of follow-up. We found that women with better motivation had a lower hazard of all-cause mortality in unadjusted analysis. This effect diminished after adjusting for confounding variables age, stage of breast cancer, and other HRQoL measures. We found no association between motivation and BC-specific mortality at 5 years and 10 years. The similar hazard ratios found by our sensitivity analysis using GOB as a continuous variable suggest that selecting a different cutoff other than 80 would not have changed the results. Our findings extend the goals of the original GOB validation study, which highlighted the need to further test GOB's predictive ability over longer periods of time (8). Our results partially support our hypothesis in that GOB would be related to mortality, however they do not support our hypothesis that this relationship is independent of the other clinical and HRQoL variables included as confounders in adjusted analyses (as depicted in **Figure 1**).

Previous studies have measured concepts similar to motivation such as hope and optimism and found them to be related to health outcomes in a variety of patient populations. However the evidence is equivocal that these concepts are independently associated with mortality in cancer patients (42-45). In support of an independent association, "dispositional optimism" was found to predict one-year survival in patients with head and neck cancer (46), "pessimism" was linked to lower survival in lung

cancer patients (47), and a hope for the curability of cancer correlated with higher survival in nonmetastatic colon cancer patients (48). Other studies do not support an independent association between measures similar to motivation and mortality: in over 90,000 women from the Women's Health Initiative who were at baseline free of cardiovascular disease and cancer, optimism measured using the Life Orientation Test-Revised was found to be independently associated with a lower hazard of coronary heart disease and coronary heart disease-related mortality in all patients, but was found only in black patients to be independently associated with cancer-related mortality (49). Our analysis of all-cancer mortality found a weak association with high GOB in unadjusted analyses that diminished after adjustment for age, stage, and other HRQoL variables, akin to the results of the analysis conducted on our main outcomes of breast cancer-specific and all-cause mortality (**Supplementary Table 3)**. In patients with advanced colon cancer, Schofield et al. measured hopefulness and optimism using the State Hope Scale (50) and Life Orientation Test (51), respectively (24). The authors found that baseline hopefulness was associated with overall survival in unadjusted analysis, whereas optimism was not. Similar to our study, the association between hopefulness and survival weakened after adjusting for known prognostic variables. Our results suggest that much of the decrease in mortality in women with baseline GOB $\geq$ 80 vs. women with GOB < 80 was because women with GOB$\geq$ 80 were younger and/or had less advanced disease, not because they had higher levels of motivation per se. Moreover, younger patients are more likely to have fewer comorbidities and receive guideline-recommended therapy – two factors not included in our analysis that might also contribute to lower mortality (52-57).

Our study shows that the relation between GOB and mortality is confounded not only by age and cancer stage, but also by the HRQoL variables included in our study **(Table 3)**. We found weak to moderate correlations among GOB, MHI-5, PFI-10, BCSEH, CARES-SF, and mMOS-SS **(Table 4)**, complementing the original GOB study that found associations between GOB and MHI-5 as well as GOB and PFI-10 both at baseline and at 6 months (8). Other studies have found relations between measures similar to motivation (GOB) and each of the other HRQoL variables studied (8, 17-19, 25-27, 30, 31). Physical function and mental health were not only related to GOB (**Table 4**) but were also independently associated with mortality (**Table 3**, PFI-10 with all-cause mortality and MHI-5 with both all-cause and BC-specific mortality). This finding reinforces prior research (16, 23, 52, 58). Schofield et al. noted that after adjusting for factors such as depression – a variable similar to general mental health that they found to be negatively correlated with hope – the unadjusted association between hope and mortality weakened (24). Likewise, our results suggest that even after adjusting for age and stage, much of the remaining decrease in mortality in women with baseline GOB $\geq$ 80 was because these women had higher scores of mental health and physical functioning, not a higher score of motivation.

Strengths of our study include the long follow-up period, tracking mortality in participants for 10 years. Further, survival status was complete through 10 years, thus avoiding selection bias due to lost to follow-up. Limitations include a population that was largely white, well-educated, and from four specific regions in the US, limiting the generalizability of our findings. Whereas we found that GOB was not independently associated with breast cancer-specific or all-cause mortality, we did not test whether it was associated with other important outcomes such as disability-free life expectancy or hospitalization. If an independent association between motivation and mortality does exist, a larger sample size may have been necessary to detect it. Moreover, GOB was validated in only one study, and GOB's four questions and the manner in which they are worded might not adequately stratify patients into high and low risk in terms of mortality; measures of motivation with more items and different content might be more discriminatory. Lastly, the low number of deaths within 5 years and breast cancer-related deaths within 10 years coupled with the observed moderate correlations between investigated HRQoL measures increase imprecision in model estimates, given by the bias-

variance trade-off. Thus, point estimates from adjusted models in our data might vary across different models due to wide confidence intervals rather than reflecting the true population values.

In conclusion, our results suggest that a previously validated measure of motivation, GOB, is associated with other important HRQoL variables. However, independent of these variables and age and stage of cancer, GOB is weakly associated with mortality. There is a great need for efficient strategies to risk stratify older adults with cancer, as they are different from younger patients with respect to life expectancy, physiologic reserve, and life values (59). Our study suggests that GOB does not contribute to the goal of aiding providers and researchers with a stand-alone tool that can predict mortality in older cancer patients; other strategies, namely Comprehensive Geriatric Assessment, have shown more promise to that end (52, 60-67). However, GOB is a measure of motivation that reflects other HRQoL variables and like these other HRQoL variables might be an important outcome to monitor in older cancer patients, either by itself or as part of longer instruments. Its brevity paired with its proven internal reliability and stability over time support this purpose (8). It has not only been shown to correlate with other HRQoL variables, as in the current study, but has also been shown to be predictive of HRQoL variables such as mental, emotional, and self-perceived health. More promising are our findings that build on the growing evidence linking mental and physical function to mortality, both of which are domains of the Comprehensive Geriatric Assessment. Further research using these HRQoL variables by themselves or in combination with other known predictive factors such as age and stage could lead to brief yet powerful prognostic tools to help guide treatment of older cancer patients.

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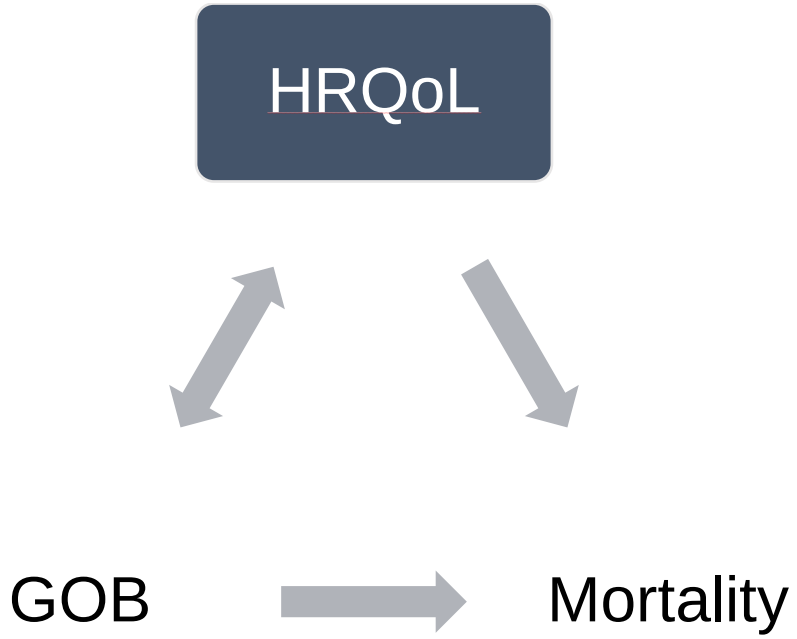
Figure 1: Hypothesized relationships among Getting Out of Bed (GOB), health-related quality of life (HRQoL) variables, and mortality*.



* GOB affects mortality and is associated with HRQoL, which also affects mortality. Therefore, any observed effect GOB may have on mortality might in fact be due to its association with HRQoL (12). This confounding situation can be solved by adjusting for HRQoL, such that GOB is an independent predictor for mortality.

Table 1: Getting out of bed questionnaire.

"This set of questions asks about things that encourage you to get up each morning and begin your day. Please indicate whether it is an Excellent description of you, a Very Good description of you, a Good description of you, a Fair description of you, or a Poor description of you.

GOB Item	Excellent	Very Good	Good	Fair	Poor
1. I am the type of person who almost always has a reason to get out of bed in the morning.	5	4	3	2	1
2. It is important for me to get out of bed each day and to do what I have to do.	5	4	3	2	1
3. I have reasons in my life to get up and to get going every day.	5	4	3	2	1
4. In the future, I am sure there will be things in my life to keep me getting up each day.	5	4	3	2	1

Table 2: Baseline socio-demographic and health-related characteristics in a population of older women with breast cancer (N=660).

Characteristic	n (%) / Median (IQR)
Enrollment site	
Los Angeles	150 (22.7)
Rhode Island	163 (24.7)
Minnesota	188 (28.5)
North Carolina	159 (24.1)
Age	
65–69 years	172 (26.1)
70–79 years	372 (56.4)
80+ years	116 (17.6)
Ethnicity	
White	620 (93.9)
Other	40 (6.1)
Education	
Less than 12 years	115 (17.4)
12 years	228 (34.5)
More than 12 years	316 (47.9)
Missing	1 (0.1)
Marital status	
Married	304 (46.1)
Not married	356 (53.9)
Breast Cancer Stage	
I	336 (50.9)
II	298 (45.1)
III	25 (3.8)
Missing	1 (0.1)
Type of therapy	
BCS	317 (48.0)
Mastectomy	316 (47.9)
Other	17 (2.6)
Missing	10 (1.5)
GOB	75.0 (31.2)
GOB ≥ 80	315 (47.7)
GOB < 80	321 (48.6)
Missing	24 (3.6)
PFI-10	90.0 (33.3)
PFI-10 ≥ 80	428 (64.8)
PFI-10 < 80	229 (34.7)
Missing	3 (0.5)
MHI-5	84.0 (20.0)
MHI-5 ≥ 80	455 (68.9)
MHI-5 < 80	204 (30.9)
Missing	1 (0.5)
BCSEH	75.0 (31.2)
BCSEH ≥ 80	403 (61.1)
BCSEH < 80	212 (32.1)
Missing	45 (6.8)
CARES-SF	82.1 (19.6)
CARES-SF ≥ 80	381 (57.7)
CARES-SF < 80	279 (42.3)
mMOS-SS	81.2 (31.2)
mMOS-SS ≥ 80	333 (50.5)
mMOS-SS < 80	327 (49.5)

IQR: Interquartile range; GOB: Getting-Out-of-Bed Scale; PFI-10: Physical Function Index; MHI-5: General mental health; BCSEH: Breast cancer-specific emotional health; CARES-SF: Cancer-specific psychosocial function; mMOS-SS: Modified Social Support Scale.

Table 3: Five- and ten-year survival analysis for all-cause and breast-cancer-specific mortality*.

		All-cause mortality		Breast-cancer-specific mortality	
		5-years	10-years	5-years	10-years
		HR (95%CI)	HR (95%CI)	HR (95%CI)	HR (95%CI)
Model 1†:					
GOB ≥ 80 at baseline		0.78 (0.52, 1.19)	0.77 (0.59, 1.00)	0.92 (0.49, 1.74)	0.82 (0.52, 1.32)
Model 2†:					
GOB ≥ 80 at baseline		0.87 (0.57, 1.32)	0.84 (0.64, 1.10)	1.05 (0.55, 1.99)	0.89 (0.56, 1.43)
Age	65-69 years	Reference	Reference	Reference	Reference
	70-79 years	1.05 (0.61, 1.83)	1.43 (1.00, 2.05)	1.11 (0.46, 2.70)	1.17 (0.65, 2.1)
	80+ years	2.92 (1.65, 5.15)	3.18 (2.14, 4.71)	3.04 (1.23, 7.51)	2.00 (1.02, 3.95)
Stage	I	Reference	Reference	Reference	Reference
	II	1.51 (1.0, 2.30)	1.42 (1.09, 1.86)	6.84 (2.65, 17.7)	5.27 (2.81, 9.86)
	III	3.05 (1.43, 6.54)	3.20 (1.91, 5.37)	12.2 (3.28, 45.6)	10.2 (4.01, 26.0)
Model 3†:					
GOB ≥ 80 at baseline		1.04 (0.65, 1.66)	1.08 (0.80, 1.46)	1.10 (0.53, 2.27)	1.02 (0.59, 1.74)
Age	65-69 years	Reference	Reference	Reference	Reference
	70-79 years	1.02 (0.58, 1.77)	1.37 (0.96, 1.97)	1.10 (0.45, 2.67)	1.18 (0.65, 2.12)
	80+ years	3.25 (1.79, 5.89)	3.11 (2.07, 4.66)	3.62 (1.4, 9.40)	2.27 (1.12, 4.61)
Stage	I	Reference	Reference	Reference	Reference
	II	1.42 (0.93, 2.15)	1.40 (1.06, 1.83)	6.44 (2.49, 16.7)	5.12 (2.73, 9.61)
	III	2.58 (1.19, 5.62)	3.05 (1.80, 5.14)	10.2 (2.66, 38.8)	8.93 (3.45, 23.1)
PFI-10 ≥ 80 at baseline		0.64 (0.43, 0.97)	0.63 (0.48, 0.82)	0.83 (0.43, 1.61)	0.85 (0.52, 1.39)
MHI-5 ≥ 80 at baseline		0.43 (0.28, 0.68)	0.60 (0.45, 0.80)	0.46 (0.22, 0.97)	0.54 (0.32, 0.93)
BCSEH ≥ 80 at baseline		1.21 (0.72, 2.04)	0.93 (0.66, 1.31)	1.46 (0.65, 3.26)	1.14 (0.63, 2.08)
CARES-SF ≥ 80 at baseline		0.73 (0.47, 1.12)	0.96 (0.72, 1.26)	0.75 (0.38, 1.50)	0.88 (0.53, 1.46)
mMOS-SS ≥ 80 at baseline		1.26 (0.81, 1.98)	0.84 (0.62, 1.12)	1.41 (0.68, 2.91)	1.06 (0.63, 1.78)

HR: Hazard ratio; CI: Confidence interval; GOB: Getting-Out-of-Bed Scale; PFI-10: Physical Function Index; MHI-5: General mental health; BCSEH: Breast cancer-specific emotional health; CARES-SF: Cancer-specific psychosocial function; mMOS-SS: Modified Social Support Scale.

* All estimates from multiple imputed baseline variables using Cox regression.

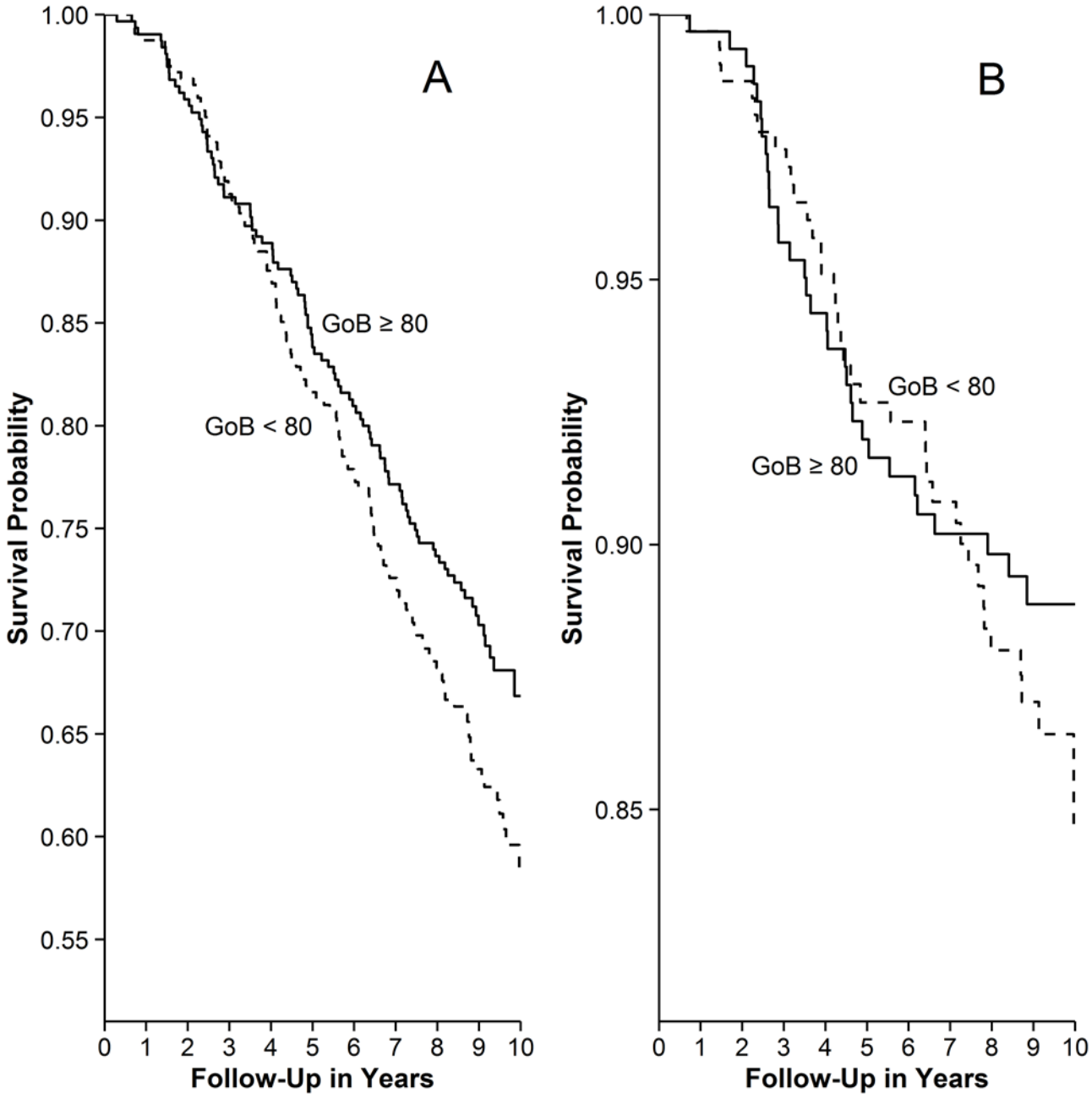
† Model 1: Unadjusted; Model 2/3: Adjusted for all listed variables.

Table 4: Spearman rank correlations between baseline HRQoL measures.

	GOB	PFI-10	MHI-5	BCSEH	CARES-SF	mMOS-SS
GOB	1.00					
PFI-10	0.17	1.00				
MHI-5	0.33	0.26	1.00			
BCSEH	0.49	0.11	0.44	1.00		
CARES-SF	0.26	0.16	0.43	0.52	1.00	
mMOS-SS	0.36	0.14	0.31	0.45	0.39	1.00

GOB: Getting-Out-of-Bed Scale; PFI-10: Physical Function Index; MHI-5: General mental health; BCSEH: Breast cancer-specific emotional health; CARES-SF: Cancer-specific psychosocial function; mMOS-SS: Modified Social Support Scale.

Figure 2: Kaplan-Meier survival curves comparing A) survival from all-cause mortality and B) survival from breast-cancer-specific mortality between subjects with GOB ≥ 80 and those with GOB < 80*****.



***** Graphs based on complete case results.

Supplemental Table 1: Five- and ten-year survival analysis for all-cause and breast-cancer-specific mortality from complete case analysis using Cox regression models.

		All-cause mortality		Breast-cancer-specific mortality	
		5-years	10-years	5-years	10-years
		HR (95%CI)	HR (95%CI)	HR (95%CI)	HR (95%CI)
Model 1*:					
GOB ≥ 80 at baseline		0.80 (0.53, 1.21)	0.78 (0.60, 1.02)	0.94 (0.50, 1.77)	0.84 (0.52, 1.34)
Model 2*:					
GOB ≥ 80 at baseline		0.86 (0.56, 1.3)	0.84 (0.64, 1.10)	0.99 (0.52, 1.91)	0.87 (0.54, 1.41)
Age	65-69 years	Reference	Reference	Reference	Reference
	70-79 years	0.98 (0.56, 1.72)	1.40 (0.98, 2.01)	1.15 (0.47, 2.78)	1.18 (0.65, 2.13)
	80+ years	2.68 (1.50, 4.78)	3.05 (2.05, 4.54)	2.73 (1.08, 6.89)	1.88 (0.94, 3.78)
Stage of breast cancer	I	Reference	Reference	Reference	Reference
	II	1.54 (1.00, 2.37)	1.47 (1.12, 1.94)	6.54 (2.52, 17.0)	5.61 (2.92, 10.8)
	III	3.00 (1.33, 6.74)	3.12 (1.80, 5.39)	12.4 (3.33, 46.4)	11.4 (4.40, 29.4)
Model 3*:					
GOB ≥ 80 at baseline		0.95 (0.59, 1.55)	1.05 (0.77, 1.42)	0.94 (0.44, 2.02)	0.93 (0.53, 1.63)
Age	65-69 years	Reference	Reference	Reference	Reference
	70-79 years	1.03 (0.58, 1.82)	1.37 (0.95, 1.97)	1.32 (0.51, 3.36)	1.26 (0.69, 2.32)
	80+ years	2.73 (1.44, 5.17)	2.84 (1.86, 4.34)	3.28 (1.15, 9.40)	2.14 (1.00, 4.58)
Stage of breast cancer	I	Reference	Reference	Reference	Reference
	II	1.38 (0.88, 2.17)	1.37 (1.03, 1.83)	5.52 (2.11, 14.5)	4.97 (2.57, 9.60)
	III	2.36 (1.01, 5.49)	2.90 (1.65, 5.09)	9.23 (2.38, 35.8)	8.93 (3.37, 23.7)
PFI-10 ≥ 80 at baseline		0.60 (0.39, 0.94)	0.63 (0.47, 0.84)	0.85 (0.42, 1.72)	0.95 (0.57, 1.60)
MHI-5 ≥ 80 at baseline		0.45 (0.27, 0.74)	0.58 (0.43, 0.79)	0.51 (0.23, 1.13)	0.53 (0.30, 0.92)
BCSEH ≥ 80 at baseline		1.43 (0.84, 2.43)	1.00 (0.70, 1.41)	1.65 (0.72, 3.78)	1.23 (0.67, 2.28)
CARES-SF ≥ 80 at baseline		0.74 (0.46, 1.17)	1.01 (0.75, 1.36)	0.78 (0.37, 1.63)	0.97 (0.56, 1.66)
mMOS-SS ≥ 80 at baseline		1.27 (0.78, 2.07)	0.83 (0.61, 1.14)	1.49 (0.69, 3.23)	1.12 (0.65, 1.94)

HR: Hazard ratio; CI: Confidence interval; GOB: Getting-Out-of-Bed Scale; PFI-10: Physical Function Index; MHI-5: General mental health; BCSEH: Breast cancer-specific emotional health; CARES-SF: Cancer-specific psychosocial function; mMOS-SS: Modified Social Support Scale.

* Model 1: Unadjusted; Model 2/3: Adjusted for all listed variables.

Supplemental Table 2: Five- and ten-year survival analysis for all-cause and breast-cancer-specific mortality using non-dichotomized standardized health measures from Cox regression models.

		All-cause mortality		Breast-cancer-specific mortality	
		5-years	10-years	5-years	10-years
		HR (95%CI)	HR (95%CI)	HR (95%CI)	HR (95%CI)
Model 1*:					
GOB linear†		0.90 (0.74, 1.09)	0.85 (0.75, 0.96)	1.00 (0.73, 1.36)	0.95 (0.75, 1.19)
Model 2*:					
GOB linear†		0.96 (0.79, 1.17)	0.89 (0.79, 1.01)	1.09 (0.79, 1.50)	1.01 (0.80, 1.27)
Age	65-69 years	Reference	Reference	Reference	Reference
	70-79 years	1.06 (0.61, 1.84)	1.43 (1.00, 2.04)	1.13 (0.47, 2.73)	1.18 (0.66, 2.13)
	80+ years	2.94 (1.66, 5.20)	3.13 (2.11, 4.64)	3.11 (1.26, 7.70)	2.04 (1.03, 4.02)
Stage of breast cancer	I	Reference	Reference	Reference	Reference
	II	1.51 (1.00, 2.29)	1.41 (1.08, 1.85)	6.89 (2.67, 17.8)	5.28 (2.82, 9.88)
	III	3.07 (1.43, 6.56)	3.20 (1.91, 5.36)	12.6 (3.28, 45.7)	10.3 (4.06, 26.3)
Model 3*:					
GOB linear†		1.08 (0.86, 1.36)	1.06 (0.91, 1.23)	1.11 (0.77, 1.62)	1.12 (0.84, 1.48)
Age	65-69 years	Reference	Reference	Reference	Reference
	70-79 years	1.07 (0.61, 1.88)	1.40 (0.98, 2.01)	1.23 (0.50, 3.02)	1.27 (0.70, 2.30)
	80+ years	3.06 (1.67, 5.61)	3.11 (2.06, 4.70)	3.68 (1.38, 9.84)	2.42 (1.17, 5.01)
Stage of breast cancer	I	Reference	Reference	Reference	Reference
	II	1.44 (0.94, 2.19)	1.41 (1.07, 1.86)	6.34 (2.44, 16.5)	5.10 (2.71, 9.59)
	III	2.82 (1.29, 6.16)	3.07 (1.81, 5.20)	11.2 (2.90, 43.1)	9.10 (3.49, 23.7)
PFI-10 at baseline, linear†		0.80 (0.66, 0.97)	0.76 (0.67, 0.87)	1.03 (0.73, 1.45)	0.98 (0.76, 1.26)
MHI-5 at baseline, linear†		0.79 (0.63, 0.99)	0.84 (0.72, 0.97)	0.79 (0.55, 1.12)	0.77 (0.60, 0.99)
BCSEH at baseline, linear†		1.08 (0.82, 1.42)	0.96 (0.80, 1.14)	1.31 (0.85, 2.01)	1.03 (0.76, 1.41)
CARES-SF at baseline, linear†		0.95 (0.74, 1.22)	1.04 (0.88, 1.22)	0.79 (0.54, 1.15)	0.98 (0.74, 1.31)
mMOS-SS at baseline, linear†		1.04 (0.81, 1.33)	0.94 (0.80, 1.10)	1.09 (0.73, 1.63)	1.01 (0.75, 1.35)

HR: Hazard ratio; CI: Confidence interval; GOB: Getting-Out-of-Bed Scale; PFI-10: Physical Function Index; MHI-5: General mental health; BCSEH: Breast cancer-specific emotional health; CARES-SF: Cancer-specific psychosocial function; mMOS-SS: Modified Social Support Scale.

* Model 1: Unadjusted; Model 2/3: Adjusted for all listed variables.

† Per 1-unit SD increase.

Supplemental Table 3: Five- and ten-year survival analysis for all-cancer mortality*.

		All-cancer mortality	
		5-years	10-years
		HR (95%CI)	HR (95%CI)
Model 1†:			
GOB ≥ 80 at baseline		0.86 (0.50, 1.48)	0.78 (0.53, 1.14)
Model 2†:			
GOB ≥ 80 at baseline		0.93 (0.53, 1.61)	0.83 (0.56, 1.22)
Age	65-69 years	Reference	Reference
	70-79 years	0.77 (0.39, 1.53)	1.14 (0.71, 1.82)
	80+ years	2.18 (1.08, 4.42)	1.87 (1.08, 3.25)
Stage	I	Reference	Reference
	II	2.35 (1.31, 4.21)	2.60 (1.71, 3.96)
	III	3.59 (1.21, 10.7)	5.64 (2.77, 11.5)
Model 3†:			
GOB ≥ 80 at baseline		0.96 (0.51, 1.80)	0.92 (0.59, 1.42)
Age	65-69 years	Reference	Reference
	70-79 years	0.76 (0.38, 1.52)	1.13 (0.70, 1.81)
	80+ years	2.59 (1.23, 5.44)	1.91 (1.08, 3.39)
Stage	I	Reference	Reference
	II	2.23 (1.25, 4.00)	2.56 (1.68, 3.90)
	III	2.91 (0.96, 8.88)	5.18 (2.51, 10.7)
PFI-10 ≥ 80 at baseline		0.89 (0.51, 1.55)	0.76 (0.51, 1.12)
MHI-5 ≥ 80 at baseline		0.45 (0.24, 0.83)	0.72 (0.47, 1.11)
BCSEH ≥ 80 at baseline		1.34 (0.68, 2.66)	1.05 (0.65, 1.70)
CARES-SF ≥ 80 at baseline		0.85 (0.48, 1.52)	0.91 (0.60, 1.37)
mMOS-SS ≥ 80 at baseline		1.44 (0.79, 2.63)	1.02 (0.68, 1.55)

HR: Hazard ratio; CI: Confidence interval; GOB: Getting-Out-of-Bed Scale; PFI-10: Physical Function Index; MHI-5: General mental health; BCSEH: Breast cancer-specific emotional health; CARES-SF: Cancer-specific psychosocial function; mMOS-SS: Modified Social Support Scale.

* All estimates from multiple imputed baseline variables using Cox regression.

† Model 1: Unadjusted; Model 2/3: Adjusted for all listed variables.